RESEARCH ARTICLE

Use of information technology to improve patient compliance: A pilot study

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ABSTRACT

**Background:** Compliance with treatment is the key link between treatment and outcome in medical care, non-compliance leads to failure of treatment. Non-compliance with antimicrobial agents (AMAs) is the important reason for Resistance to antimicrobials. Forgetting to take medicine is one of the important causes of non-compliance. **Aim and Objectives:** Hence, the present study was planned to evaluate the compliance for antimicrobial treatment in patients receiving a short course of antimicrobials, with or without reminding them to take medicine using a smartphone app. **Materials and Methods:** Prospective interventional study was planned in a tertiary care hospital after permission from the ethics committee. The present pilot work of the study was carried out on 30 patients receiving AMAs. Patients receiving a short course of chemotherapy were enrolled and stratified based on the frequency of administration of antimicrobials. They were then allocated alternately in control (15) and study (15) groups. After explaining the prescription to all, “Pill Reminder” app was downloaded on smartphones of participants in the study group. All were contacted to enquire about compliance at the end of the treatment period. **Results:** Baseline characteristics of participants in both groups were comparable. URTI, UTI, Tinea cruris, Tinea capitis were the disorders for which they received AMAs. The frequency of administration was once/twice/thrice a day. Duration was 3–14 days in both groups. At the end of the study, 53.3% of patients in control group and 100% of patients in intervention group were compliant to the treatment. **Conclusion:** The use of the reminder app significantly improved patient’s compliance with medications. Further studies are required to validate these results.

**KEY WORDS:** Compliance; Antimicrobial Agents; Pill Reminder App

INTRODUCTION

Patient compliance has been defined as “the extent to which a person’s behavior (in terms of taking medications, following diets, or executing lifestyle changes) coincides with medical or health advice.”[1] Whereas patient non-compliance is defined as any deviation by a patient from a doctor’s instructions. Non-compliance for medication has been found to be associated with treatment failure and all its consequences, namely: Deterioration of patients’ health, the need for additional consultations, the use of extra drugs, additional hospital admissions, or increased hospital stay which leads to an increase in direct and indirect costs of management.[2]

The World Health Organization report on adherence to long-term therapies suggests that patients adhere to only 50% of drugs prescribed for chronic diseases in developed nations, a figure which is even lower in developing countries.[3]

Compliance with treatment is the key link between treatment and outcome in the medical care. Patient compliance plays a key role in the success of medical management. It is a...
major challenge for both patient and physician. One of the important causes of non-compliance is not remembering to consume the medication, once the patient feels better. When the patient is admitted to the hospital, it is the responsibility of nurses to ensure compliance with the medication. But for outdoor patients, he/she should remember to consume it.

Non-compliance/non-adherence is particularly important with antimicrobial regimens. Some patients take additional doses of antibiotics, especially at the beginning of the treatment. This probably is related to the severity of the symptoms and the patients’ desire to get better promptly. Others may decrease the frequency of their doses, for example, twice a day instead of three times a day. Noncompliance in this direction can lead to antibiotic resistance which can endanger not only the defaulting patient but also the entire community.

One of the ways to improve compliance is to remind the patient to take medication. While thinking on this line, we thought of using modern technology, in terms of mobile phones. Worldwide, mobile phones have invaded all facets of daily life and India is no exception. To tackle the problem of non-compliance many apps are developed. Available apps require patients to enter the medication details and set reminder alarms. It is observed that many patients find this difficult and then tend not to use the app. In addition, if they make mistakes in entering the details, the patient would end up taking wrong medication/wrong doses/wrong duration and thus effectively the utility of app reduces.

Hence, we screened the available apps and used one which we felt would be most useful to remind patients to consume medications and evaluated how much it can help to improve the compliance.

Objectives
1. To select the user-friendly app and download it on the patient’s mobile
2. To compare compliance of patients on antimicrobial therapy with and without reminder web application (App).

MATERIALS AND METHODS

Study Area
Tertiary care hospital-Outpatient Department (OPD) of medicine, skin, ENT.

Study Sample
Sample size estimation was done considering the prevalence of compliance to medication as (65.71%). Allowable error d = 16%. Power is 80%.

Obtained sample size was for each group = 145.

For the pilot study, sample size = 15 Participants in each group (10% of sample).

Period of Study
June-August 2019.

Research Design
A prospective interventional study.

Ethics Approval
REF: BVDUMC/IEC/35.

Inclusion Criteria
- Patients attending OPD of medicine/Dermatology/ENT who were prescribed a short course of antimicrobial agents (AMAs).
- Duration of treatment: 3days-2 wks.
- Patients comfortable with using a smartphone application in English.
- Patients available for telephonic follow-up for the duration of antimicrobial treatment.
- Patients willing to give written informed consent for participating in the study.

Exclusion Criteria for Participants
Patients using AMAs for chronic diseases such as T.B., Leprosy, and HIV.

Methodology
Patients from medicine, Dermatology, and ENT OPD were included in the study. After applying selection criteria and taking informed written consent, total of 30 patients were enrolled into the study. They were stratified according to the frequency of administration of prescribed antimicrobials and then alternately placed in control and intervention groups.

Participants in both the groups were explained about the prescribed medicines and how they should be taken. They were also explained the importance of taking them as prescribed.

For the intervention group, the “Pill Reminder” app was downloaded on their Smartphone. Antimicrobial details like- name of the AMA, its dosage, time of administration, were entered in the app. The alerts were set for a particular time and for a number of days according to the treatment schedule. Patients were instructed to consume the medicine as soon as a reminder pops up on their screen.
Specifications of App used in our study:
• User-friendly interface—easy to enter medication details
• Personalized reminders for each day
• Ability to snooze reminder so that if a patient has not taken medication it will remind repeatedly
• Customizable alert sounds
• Availability of different icons for Tablets, syringes, drops, etc.
• Reminders with no internet connectivity.

After completion of the antimicrobial course, patients were contacted telephonically to enquire about the adherence to the treatment. Patients on the treatment of 3/5/7 day’s duration were contacted at the end of the treatment. Those on a longer duration of treatment were contacted once weekly.

They were asked about missed dose of antimicrobial drugs:
• Whether they took the missed medicine at any other time (two doses at the same time)
• Number of days they missed the medicine
• Whether they stopped the treatment prematurely
• Reason for missing the medication.

Statistical Analysis
The collected data were entered in an excel sheet and analyzed using Statistical Package for Social Sciences version 25.0 software. Continuous variables are shown by descriptive statistics and categorical variables expressed as frequencies and percentages. Graphs were added whenever necessary. Group comparison of categorical variables was done by Chi-square test. Z-TEST for the difference between two proportions was used to test the proportion of compliance between the intervention and control groups. \( P < 0.05 \) is considered as a statistically significant.

RESULTS

Demographic Details
For this study, enrolled participants were between 20 and 50 years of age and gender distribution was equal in control and intervention group [Figure 1]. Minimum qualification was graduation. Most of them (60%) were working, 30% were students and 10% were housewives. All participants were from medium socioeconomic group. Table 1 indicates infections and AMAs prescribed in both the groups. Respiratory tract infections and fungal infections (Tinea cruris and Tinea capitis) were the major infections encountered. Azithromycin, Amoxicillin, Amoxicillin-clavulanic acid, and Itraconazole, were frequently used AMAs in both the groups.

Table 2 indicates the number of participants according to the frequency of administration of AMAs. Because of stratification and alternately allocating the participants into control and intervention groups, participants in both the groups were equal.

Table 3 shows that the duration of treatment with AMAs varied from 3 days to 14 days. Number of participants were similar for 3, 5, and 14 days of treatment. One participant each was present taking 7/10 days of treatment. For duration of treatment, both the groups were comparable.

In the control group, about 66% and 60% compliance was present, respectively, for once or twice a day administration of AMAs. Compliance for thrice a day administration was zero percent, in the control group. As against this, in intervention group, there was complete (100%) adherence, for participants in all the groups [Figure 2].

![Figure 1: Consort diagram](image-url)
As far as the duration of treatment was concerned, there was complete adherence in intervention group in contrast to control group [Figure 3].

Z test was used to compare the proportion of compliant participants in both the groups. Proportion of compliance in the intervention group was highly significantly different in comparison to control group ($P = 0.003$) [Table 4].

**DISCUSSION**

Patient compliance plays a major role in the efficacy of treatment. Noncompliance or poor adherence to medications is a common and major barrier to achieve good clinical outcomes. Noncompliance appears to be very common with chronic conditions and is considerably more common for asymptomatic chronic conditions like hypertension and hyperlipidemia.$^{[10]}$ In acute conditions such as respiratory tract infection having symptoms such as cough, fever, and malaise, we expect high degree of compliance from patients. Surprisingly, Cockburn et al. in their study observed non-compliance even in these patients with basic medications like antibiotics.$^{[9]}$ Nowadays, emergence of resistance to AMAs is a major health problem, worldwide.$^{[10]}$ Antimicrobials can reduce the number of organisms or kill them effectively, only if their concentration is maintained at a stipulated level, which can be ensured by adhering to the correct dosing schedule. Poor compliance to AMAs has been shown to be a major determinant of medication failure, emergence of drug resistant microbes, disease progression, increased stay

| Table 1: Infections and antimicrobial agents used in the study groups |
|---------------------------|-----------------|
| Infections                | AMAs used       |
| Upper respiratory tract infection | Azithromycin, amoxicillin-clavulanic acid |
| Lower respiratory tract infection | Azithromycin, amoxicillin-clavulanic acid, amoxicillin |
| Otitis media              | Amoxicillin-clavulanic acid |
| Urinary tract infection    | Amoxicillin-clavulanic acid |
| Infective Diarrhoea        | Ciprofloxacin   |
| Acne                      | Doxycycline     |
| T. Cruris and T. Corporis | Itraconazole    |

AMAs: Antimicrobial agent

| Table 2: Participant distribution according to the frequency of administration of AMA |
|--------------------------------|----------------|----------------|----------------|
| Frequency of medication    | Control group | Intervention group |
| No. of participants       | No. of participants |
| Once a day                 | 3              | 3              |
| Twice a day                | 10             | 10             |
| Thrice a day               | 2              | 2              |
| Total patients-(15)        | Total patients-(15) |

AMAs: Antimicrobial agent

| Table 3: Participant distribution according to the duration of treatment |
|---------------------------|----------------|----------------|
| Duration of treatment in days | Control group | Intervention group | P-value |
| No. of participants       | No. of participants |              |
| 3                         | 1              | 1              | 0.736 |
| 5                         | 8              | 8              | Chi-square value-2.0 |
| 7                         | 1              | 0              | |
| 10                        | 0              | 1              | |
| 14                        | 5              | 5              | |
| Total patients-15         | Total patients-15 |

| Table 4: Overall Participant compliance for AMAs in the present study |
|---------------------------|----------------|----------------|
| Control group (n=15)      | Intervention group (n=15) |
| Compliant                 | Non-compliant | Compliant | Non-compliant |
| 8 patients (53.3%)         | 7 patients (46.7%) | 15 patients (100%) | NIL |
| *P-value =0.003*          |                      |               |               |

AMAs: Antimicrobial agent
in hospital, mortality, and eventually, increasing health care costs.\[^{11}\] Improvement in patient’s compliance, therefore, is the need of the hour. We can take optimum care of indoor patients and ensure the administration of medication by hospital staff. The main problem arises in treating outdoor patients. Across the world, the use of smart phones has increased enormously. Therefore, we thought of using Smartphone apps (which are available on IOS and Android both), as a potential tool to improve medication adherence. So, the present study was planned to evaluate the compliance for antimicrobial treatment in participants receiving short course of antimicrobials, with or without the use of Smartphone app.

Participants enrolled in the study were suffering from common disorders such as upper and lower respiratory tract infections, urinary tract infections, Acne, Tinea cruris/capitis, Infective diarrhea, Otitis media, and externa. AMAs used were Amoxicillin, Azithromycin Amoxicillin-clavulanic acid, Doxycycline, Itraconazole, Ciprofloxacin [Table 1].

In the present study, in the control group, out of 15 participants eight participants completed their medication in appropriate dose, frequency, and duration. They did not miss even a single dose. Remaining seven participants had missed some doses of prescribed antimicrobials (tablets/caps) [Table 4]. We tried to find out the reason for missing doses. Common reason quoted was “Forgot to take,” while they were working or were in the college. Favre et al. in their study observed that most of the times adherence to treatment dwindles while working.\[^{12}\] This increases the gap between the doses, mainly during daytime, which may be as long as 14–16 h. Patient’s education and doctorpatient relationship play an important role in patient compliance.\[^{13}\] The participants who were able to read and respond to commands in English were included in this study. Minimum qualification of study participants was graduation. Hence, educational level of all the participants was good. To overcome a problem of doctorpatient relationship and to motivate participants to take the medication as prescribed, same doctor explained the importance of adherence to the treatment in prescribed dose and duration, to all the participants.

The frequency of drug administration is a major factor affecting patient’s compliance. More frequent dosing is generally associated with reduced compliance, which is true even for antimicrobial therapy. Claxton et al. observed that with increasing dosing frequency, compliance decreases and the compliance is good if drugs are administered once/twice a day.\[^{14}\] Contrary to this observation, in our study, in control group participants were receiving medication once or twice a day and still non-compliance was present in either case [Figure 2]. Similar was the observation by Greenberg (1984), who observed that patients receiving drugs once a day also had non-compliance.\[^{15}\] In the intervention group, on the other hand, participants received medication once, twice, or thrice a day and there was no non-compliance. This indicates that “forgetting to take the medication” was the single most important cause of non-compliance in the group of participants in our study (well educated and medium socio-economic status) and so, the use of reminder app was definitely helpful. Many systems were evolved to give reminders to patients for consumption of the drugs. Amongst all the methods of reminders, app-based reminder was found to work better. A prospective interventional study was carried out by Panakkaal et al. (2018) to determine the effectiveness of a reminder card system versus a mobile application to improve medication adherence among 100 asthma patients-18 years and above, for a period of 6 months. This study concluded that the mobile application was far more effective than the pill reminder card in improving medication adherence in asthma patients.\[^{16}\] An android-based app was also developed by Deepti Ameta, Kalpana Mudaliar and Palak Patel with many additional features and was tested on 100 patients. It was reported that all of them found the app useful.\[^{17}\] Compliance also depends on the length of the treatment—shorter the duration better is the compliance and vice versa.\[^{18}\] Kardas and Reyes et al., studied the effect of duration of treatment on compliance of antimicrobial use. They observed that longer the duration, poor is the compliance.\[^{19,20}\] We had included participants with duration of treatment of 3–14 days. In the control group, non-compliance was seen across all duration of treatment. The duration of treatment was similar in the intervention group, but there was no non-compliance to indicate that reminders to consume medication can significantly improve the compliance of medication [Figure 3]. All the above observations indicate that the reminder app was useful in increasing the compliance to 100% across all dose frequencies and duration of treatment [Table 4]. Our sample size was small as it was a pilot study and the participants enrolled were educated and from medium socioeconomic status. In the actual study with large sample size, scenario may change. Similar were the findings in the studies conducted by many authors. Study conducted by Santo et al., in 2018 to determine whether medication reminder apps were useful in comparison to usual care alone. It was concluded that reminder apps brought almost 29% improvements in adherence as compared to usual care in patients with chronic heart diseases.\[^{21}\] In the present study, reminder app improved the compliance by 37%.

Limitations

There was no facility of recording compliance in the mobile app which we provided to the participants. We had to rely on the information given by patients (on telephonic enquiry) and on their memory. Participants included in the present study were educated and having reasonably good economic status. To make the data applicable to the society, wider range of people across all educational and economic strata need to be included.
CONCLUSION

The use of reminder app has definitely improved patient’s medication compliance in our pilot study. This study will provide additional evidence of effectiveness of using medication reminder apps to improve compliance of the patients on AMAs.

REFERENCES


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